INFLUENCE OF RANDOM REINFORCEMENT ON STRENGTH PROPERTIES OF FLY ASH

A Thesis submitted in partial fulfillment of the requirements for the award of the Degree of

Master of Technology in
Geotechnical Engineering

Under the guidance of

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CERTIFICATE

This is to certify that the venture entitled "***Influence of random reinforcement on the strength properties of Fly Ash***" put together by Jyoti Ranjan Behera (Roll No. 710ce1001) is in complete satisfaction of the necessities for the grant of Master of Technology Degree in Civil Engineering at NIT Rourkela is a valid work completed by him under my watch and direction.

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ACKNOWLEDGEMENT

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I am likewise appreciative to all the staff individuals from Geotechnical Engineering lab for their help and co-operation over the span of experimentation.

I likewise thank all my clump mates who have straightforwardly or in a roundabout way helped me in my task work and shared the snippets of satisfaction and distress all through the time of undertaking work.

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ABSTRACT

Soil reinforcement is a successful and solid procedure for expanding the quality and strength of soils. The system is utilized today as a part of a mixture of uses running from holding structures and banks to sub level adjustment underneath footings and asphalts. In correlation with methodically strengthened soils, arbitrarily appropriated fiber reinforced soils display a few favorable circumstances. Arrangement of arbitrarily disseminated fiber strengthened soils speaks to soil adjustment by admixture. Discrete filaments are essentially included and blended with the dirt, much like concrete, lime, or different added substances.

In current study strength analysis of fly ash reinforced with two types of fibers separately, is done. Recron fiber and Coir fiber are used as reinforcement of different length and quantity varying from 0.2 % to 2 %.Thus reinforced fly ash samples are prepared and tested.

Based on the findings of the present investigation the main conclusion arrived was Both Coir and Recron fibers are effective in increasing the strength of the compacted fly ash. This also modifies the stress-strain behavior of the mass.Increase in fiber content by mass causes increase in strength. In case of using coir fiber as reinforcement material, when the length of the fiber is increased, there is an increase in strength as well. Samples prepared under modified proctor conditions tests to show more strength than the samples prepared under standard proctor conditions at same fiber content.

CHAPTER 1

INTRODUCTION

SOIL REINFORCEMENT

Reinforcement of soil is an act of improving the strength of soil in order to enable it to carry as well as support more load than its usual abilities. The method of using reinforcement so as to improve the strength parameters of various types of weak soils has taken momentum because of the availability of various natural and artificially made materials and commercially at cheaper rates. Although the basic principles involved in reinforcing earth techniques are generally simple and have been used throughout history.

The idea of earth reinforcement is not new. The fundamental standards are shown copiously in nature by creatures and fledglings and through the activity of tree roots. The basics of the method are portrayed in the Bible, covering the support of mud or blocks with reeds or straw for the development of dwellings.

The reinforcement enhances the earth by expanding the bearing limit of the soil and decreases the settlement. It likewise lessens the liquefaction conduct of soils. The development of fortified or reinforced earth structure has turn out to be boundless in Geotechnical designing in the keep going two decades owing to their ease of development and economy contrasted with those of customary routines. Fortification of soil, is drilled to enhance the mechanical properties of the soil being fortified by the incorporation of auxiliary component, for example, granular heaps, lime/concrete blended soil, metallic bars or strips, engineered sheet, networks, cells and so forth.

One of the essential characteristics of reinforced soil is that it is made with two types of elements, soil grains and reinforcements. The basic mechanism of reinforced earth involves the generation of frictional forces between the soil and reinforcement. By means of friction the soil transfers the forces developed in earth mass to the reinforcement thus developing tension. The earth develops pseudo cohesion in the direction in which reinforcement is placed and the cohesion is proportional to tension developed in reinforcement.

PRINCIPLES BEHIND REINFORCED SOIL

Soil mass is by and large a discrete framework which comprises of soil grains. It can't hold up under pliable tension and this is especially valid on account of cohesion less soil like sand. Such soils can't be stable on steep inclines and moderately vast strains are created when outside burdens are forced on them. Reinforced earth is a composite material, a mix of soil and support suitably put to tolerate the malleable burdens created furthermore to enhance the resistance of soil toward most noteworthy tension. The vicinity of reinforcements adjusts the tension field giving a restriction generally as rubbing or attachment so that less strain is incited and pressure is evaded. Incorporations like discrete & short strands set irregular or in clear layers will likewise bestow extra resistance by method for union and grating.

FIBER REINFORCED SOIL

Arbitrarily appropriated fiber reinforced soil (RDFS) is among the most recent ground change systems in which fibers of desired type and amount are included the soil, blended haphazardly and laid in position after compaction, a strategy like ordinary adjustment methods. RDFS is unique in relation to other soil-strengthening systems in its introduction. Dissimilar to fortified earth, in randomly distributed fiber reinforced soils, the fibers are blended haphazardly in soil in this way making a homogenous mass and keep up the isotropy of the soil mass.

The use of fiber reinforcements in soil and in a random manner has many advantages over unreinforced soil. The notable advantages are using fiber as reinforcement increases the shear strength of soil thereby maintaining the strength isotropy. The use of reinforcement is advantageous for all kind of soils (i.e. sand, residue and earth). It also helps in minimizing the post peak loss of strength, flexibility is increased, resistance against seismic activities also improved, no sign of catastrophic disappointment .It also provides great ability to make use of normal or waste material which otherwise have little or no use such as coir strands, plastic strips .Use of fibers in soil holds the soil together thereby providing resistance against disintegration and also encourages vegetation development. Other notable advantages includes reduction in shrinkage and swell weights of broad soil. No obvious change in porousness of the soil. Unlike lime, concrete, and other synthetic adjustment strategies, the development utilizing fiber-support is not incredibly influenced by climate conditions. Fiber-support has been accounted for to be useful in tossing the shallow disappointment on the incline face and accordingly diminishing the cost of maintenance.

MECHANISM BEHIND REINFORCEMENT OF SOIL

Arbitrarily placed discrete fibers included into soil enhance its load deformation conduct by connecting with the soil particles mechanically through surface grinding furthermore by interlocking. The capacity of the bond is to exchange the anxiety from the dirt to the discrete considerations by assembling the elasticity of discrete filaments. Hence, fiber-support functions as frictional and pressure safe component.

MAIN TYPES OF FIBERS USED AS REINFORCEMENT

Fibers can be classified in two main categories: Synthetic fiber and Natural Fiber

- Synthetic fibers: The various types of synthetic fibers are nylon, plastic, polypropylene, glass, asbestos, etc. Since these fibers are artificially made, their strength is provided as per requirements. Thus they have more load carrying and resisting capabilities than natural fibers and thereby preferred more.

- Natural fibers: The various types of natural fiber available in India are coir, sisal, jute, hemp, bhabar, munja, bamboo, and banana. In order to minimize the cost of the reinforced soil, locally available fibers are considered in design. Because of its low quality and absence of strength, regular filaments are not utilized generally for fortifications but rather are favored for disintegration control as they are eco-accommodating.

FLY ASH: an overview

Fly powder is a fine, glass powder recouped from the gasses of blazing coal amid the creation of power. These micron-sized earth components comprise principally of silica, alumina and iron. Fly cinder intently looks like volcanic fiery remains utilized as a part of creation of the soonest known hydraulic cements around 2,300 years back. At the point when blended with lime and water the fly slag shapes a cementitious compound with properties very much alike to that of Portland concrete. On account of this closeness, fly powder can be utilized to supplant a bit of bond in the solid, giving some unmistakable quality points of interest.

Fly fiery remains, which is a coal ignition by-item, can possibly turn into one of the significant transfer issue or one of the real interchange development material arrangement of the following decade. Fly slag which can be utilized for soil changes has increased huge driving force amid the most recent two decades. Be that as it may, the present situation of the usage of fly fiery remains in India is dreary. Around 8% of the delivered fly cinder is being utilized commercaily.This demonstrates that there exists a huge capability of use of fly powder in geotechnical developments keeping in mind the end goal to safeguard the significant top soil.

Geotechnical developments like dikes, holding structures, and so on oblige tremendous measure of earth materials. Fast industrialization and non-accessibility of proper earth material have constrained the designers and researcher to use the waste result of commercial enterprises which either debase the natural posture issues for their transfer. In this association use of by- items like fly fiery remains needs unique attention. Fly ash is a result of a coal let go warm power plants and contains particles of fine sand to residue sizes. For the outline of concrete settled strengthened fly cinder structures, a legitimate study of the connection between fortification materials and balanced out fly fiery debris is important for development in the field of geotechnical engineering.

CHAPTER 2

LITERATURE REVIEW

In examination to deliberately strengthened soils, less data has been accounted for on haphazardly appropriated fiber-fortified soils in the writing. In any case, an expanding number of test and numerical studies on the subject have been directed by a few analysts in the previous couple of decades (e.g., Hoare, 1979; Wasti and Butun, 1996; Gray and Ohashi, 1983; Freitag, 1986; Gray and Al-Refeai, 1986; Maher and Gray, 1990;Ranjan et al., 1996; Bauer and Oancea, 1996; Kumar et al., 1999; Santoni et al., 2001;Kaniraj and Havanagi, 2001; Consoli et al., 1998; Michalowski and Zhao, 1996).

These previous studies indicate that the strength properties of arbitrarily distributed fiber-fortified soils are also a function of content or amount of fiber used, aspect ratio, and fiber-surface friction along with the soil and fiber index and strength characteristics.

Gray Donald H, Ohashi Harukazu. [1983]. Direct shear tests were keep running on a dry sand fortified with diverse sorts of strands. Both normal and manufactured strands in addition to metal wires were tried. Exploratory conduct was contrasted and hypothetical forecasts taking into account a power harmony model of a fiber fortified sand. Test outcomes demonstrated that fiber support expanded the crest shear quality and constrained post top diminishments in shear resistance. The fiber support show accurately anticipated the impact of different sand-fiber parameters through shear quality expands that were:

(1) Directly corresponding to fixation or territory proportion of strands;

(2) Biggest for beginning fiber introductions of 60° concerning the shear surface; and

(3) Pretty nearly the same for a fortified sand tried in a free and thick state, individually.

The discoveries of this study are applicable to such different issues as the commitment of rooftop support to the strength of sandy, coarse textured soils in granitic inclines, hill and shoreline adjustment by pioneer plants, culturing in root penetrated soils, and soil adjustment with low modulus, woven fabric.

Wasti Y., Butun M.D., [1996]. A progression of lab model tests on a strip balance bolstered by sand strengthened by haphazardly dispersed polypropylene fiber and cross section components was led with a specific end goal to contrast the outcomes and those acquired from unreinforced sand and with one another. For leading the model tests, garbs and was compacted in the test box at its ideal dampness substance and most extreme dry thickness. Three sorts of fortification, two sizes of cross section components having the same opening size and one size of fiber component cut from the lattices, were utilized as a part of shifting sums in the tests. Results demonstrated that fortification of sand by arbitrarily appropriated considerations brought on an increment in a definitive bearing limit values and the settlement at a definitive load as a rule. The adequacy of discrete strengthening components was seen to rely on upon the amount and also the state of the considerations. The bigger lattice size was discovered to be better than different incorporations considering a definitive bearing limit values. For the cross section components there gives off an impression of being an ideal incorporation proportion, while strands showed a directly expanding pattern on the premise of an increment in extreme bearing limit for the scope of support sums utilized.

McGown, Andrews & Hytiris (1985). Depleted triaxial test and model balance tests were finished. Result demonstrated that work expanded the deviator stress created at all strains, even at little strains, and the top anxieties in the sand-network blend happened at somewhat higher hub strains than for the sand alone. Huge changes were seen at all strain levels which were like triaxial tests regarding both quality and twisting attributes of fibers. Recoverable settlement plot demonstrates that where a layer of sand –mesh blend was available, just about 20% of the forced vertical settlement was recuperated, which was 4 times that for the soil alone.

Yetimoglu T., Salbas O. [2003]. A study was embraced to explore the shear quality of sands strengthened with haphazardly circulated discrete filaments via completing direct shear tests. The impact of the fiber support content on the shear quality was examined. The aftereffects of the tests showed that top shear quality and starting firmness of the sand were not influenced essentially by the fiber support. The level relocations at disappointment were additionally discovered practically identical for strengthened and unreinforced sands under the same vertical ordinary anxiety. Fiber fortifications, notwithstanding, could diminish soil fragility giving littler loss of post-top quality. Along these lines, there had all the earmarks of being an increment in remaining shear quality edge of the sand by including fiber fortifications.

Hataf N., Rahimi M.M., [**2005**]. A progression of lab model tests has been done to examine the utilizing of destroyed waste tires as support to expand the bearing limit of soil. Shred substance and shreds viewpoint proportion are the principle parameters that influence the bearing limit. Tire shreds with rectangular shape and widths of 2 and 3 cm with viewpoint proportions 2, 3, 4 and 5 are blended with sand. Five shred substance of 10%, 20%, 30%, 40% and 50% by volume were chosen. Expansion of tire shreds to sand builds BCR (bearing limit proportion) from 1.17 to 3.9 regarding shred substance and shreds viewpoint proportion. The greatest BCR is achieved at shred substance of 40% and measurements of 3 • 12 cm. It is demonstrated that expanding of shred substance expands the BCR. Then again, an ideal worth for shred substance is seen after that expanding shreds prompted abatement in BCR. For a given shred width, shred substance and soil thickness it appears that perspective proportion of 4 gives greatest BC

Miller and Rifai (2004). A series of experiments and concluded that the shrinkage crack reduction and hydraulic conductivity of compacted clay soil increased with an increase in fiber content.

Ravishankar and Raghavan affirmed that for coir balanced out lateritic soils, the greatest dry thickness (MDD) of the dirt abatements with the expansion of coir and the estimation of ideal dampness content (OMC) of the dirt increments with the increment in rate of coir. The compressive quality of the composite soil increments up to 1% of coir substance and further increment in coir quality results in decrease of the qualities.

Jamellodin et al. found that a significant change in the disappointment deviator stretch and shear quality parameters (C and U) of the delicate soil fortified with palm fibers can be accomplished. It is ob- served that the fibers demonstration to interlock particles and gathering of particles in a unitary sound grid in this way the quality properties of the dirt can be enhanced.

Chapter 3

OBJECTIVE AND SCOPE

The main purpose of this study is to determine the contribution of fibers to the strength of the fiber reinforced fly ash and also to study the effectiveness of using fiber reinforcements randomly over continuous distribution of fibers.

A secondary objective of this study is to describe the influence of various inclusion properties, soil properties, and test variables on the stress deformation response of fiber-reinforced fly ash.

The scope of this study lies in the utilization of easily available natural fibers as fiber reinforcement in weak soils as well as utilization of waste materials like fly ash for landfills, embankments , manufacture of bricks, mortar etc.

Chapter 4

EXPERIMENTAL INVESTIGATIONS

INTRODUCTION

Extensive scale usage of fly ash remains in geotechnical developments will diminish the issues confronted by the warm power plants for its transfer basically due to its property firmly related with the normal earth material. So assessment of the conduct fly powder at diverse condition is needed before its utilization as a development material in Civil designing structure. Indeed, even though sufficient substitute for full scale field tests are not accessible; tests at research facility scale give a measure to control a considerable lot of the variable experienced by and by. The patterns and conduct example saw in the research center tests can be utilized as a part of comprehension the execution of the structures in the field and may be utilized as a part of forming scientific relationship to anticipate the conduct of field structures. Subtle elements of material utilized, test planning and testing method received have been sketched out in this part.

MATERIALS USED

- ✓ **Fly ash**

Fly ash was collected in gunny bags from the sites of Adhunik Metalliks. The sample was screened through 2 mm sieve to separate out the foreign and vegetative matters. The collected samples were mixed thoroughly to get the homogeneity and air dried then oven dried at the temperature of 105-110 degree. The fly ash samples collected were reddish brown in color and rounded or semi rounded in shape.

✓ Recron fibers

Recron Fibers are built Micro Fibers with a remarkable "Triangular" Cross-area, utilized as a part of Secondary Reinforcement of Concrete. It supplements Structural Steel in improving Concrete's imperviousness to Shrinkage Cracking and enhances mechanical properties, for example, Flexural/ Split Tensile and Transverse Strengths of Concrete alongside the wanted change in Abrasion and Impact Strengths.

Features and Benefits

- Enhances Resistance to Plastics & Drying Shrinkage Cracking
- Possesses development of Cracks-extensions Micro-Cracks and gives dependability to Concrete
- Enhances Flexural Toughness/ builds Split Tensile Strength
- Upgrades Abrasion Resistance & expands Energy Absorption of Concrete in this way enhancing Impact Resistance.
- Goes about as a Pumping guide in making Concrete more homogenous
- Decreases Surface Water Absorption/ Permeability in Concrete
- Enhances Durability and Enhances Longevity of Concrete/Structure

Applications

- Pavement quality concrete
- Floorings/Grade slabs
- Parking slabs
- Foundation /retaining walls
- Water retaining structures

Specifications

Cut length:	6 mm or 12 mm
Tensile Strength:	6000-12000 kg/cm2
Melting Point:	>250 °C
Resistance to Alkali or Acid:	Good

✓ Coir Fibers

The coir is a versatile natural fiber extracted from husk of the coconut fruit generally fiber is of golden color when cleaned after removing from coconut husk. The fibers are normally 50-350 mm long. Coir degradation happens considerably more gradually than in other regular fibers. Along these lines, the fiber is extremely enduring, with infield life of 4–10 years. The water ingestion of that is around 130–180% and diameter across is around 0.1–0.6 mm. Coir holds quite a bit of its rigidity when wet. It has low tenacity yet the elongation is higher.

Figure 1 Recron fiber

Figure 2 Coir fibers

DETERMINATION OF INDEX PROPERTIES

- ✓ **Specific Gravity**

The specific gravity of fly ash sample was determined as per IS: 2720 (Part III section 1) 1980 and was found to be **2.59**

✓ Grain size distribution

For determination of grain size distribution, the fly ash was passed through test sieves having an opening size of 4.75mm, 2mm, 1mm, 600 μ , 425 μ , 300 μ , 212 μ , 150 μ ,75μ. Sieve analysis was conducted for coarser particles and hydrometer analysis was conducted for finer particles as per IS: 2720 (part IV)-1975. The percentage of fly ash passing through 75μ sieve was found to be 79.62%. Hence the particle size of fly ash ranges from fine sand to silt size.

Coefficient of uniformity (Cu) = 1.66

Coefficient of curvature (Cc) =4.88

DETERMINATION OF ENGINEERING PROPERTIES

✓ Moisture Content Dry Density Relationship

The moisture content, dry density relationship were found by using light compaction test as per IS: 2720 (part 7) and heavy compaction test as per IS: 2720 (part 8). For light compaction test fly ash was mixed with water and the mixture was compacted in Procter mound in three equal layers applying 25 number of blows to each layer by standard Procter rammer of 2.6 kg with a free fall of 310mm. For heavy compaction test fly ash was mixed with water and the mixture was compacted in Procter mound in five equal layers applying 25 number of blows to each layer by heavy Procter rammer of 4.5 kg with a free fall of 457.2 mm. The moisture content of the compacted mixture was determined as per IS: 2720 (part VII

& VIII) 1985. From the dry density and moisture content relationship, OMC and MDD are determined.

- **Unconfined Compressive Strength**

<u>Sample preparation I (Fly Ash + Recron Fibers) at Standard proctor conditions.</u>

- The specimens for UCS test are prepared by mixing required weight of fly ash and recron fibers with 36.41% water which is the optimum moisture content of fly ash under standard proctor conditions to give proper consistency to the mixture for easy moulding.
- The wet mixture is then compacted in a constant volume mould with static compactive force.
- After giving required compactive force the samples were ejected out from the mould.
- The size of specimens were 75mm dia. & 150mm in height.
- In this series of tests the percentage of fibers used were 0.2%, 0.5 %, 1 %, and 2 %.
- In this series of tests the length of fiber used was 8 mm

<u>Sample preparation I I (Fly Ash + Recron Fibers) at Modified proctor conditions.</u>

- The specimens for UCS test are prepared by mixing required weight of fly ash and recron fibers with 32.25% water which is the optimum moisture content of fly ash under modified proctor conditions to give proper consistency to the mixture for easy moulding.
- The wet mixture is then compacted in a constant volume mould with static compactive force.

- After giving required compactive force the samples were ejected out from the mould.
- The size of specimens were 75mm dia. & 150mm in height.
- In this series of tests the percentage of fibers used were 0.2%, 0.5 %, 1 %, and 2 %.

<u>Sample preparation III (Fly Ash + Coir Fibers) at Standard proctor conditions.</u>

- The specimens for UCS test are prepared by mixing required weight of fly ash and Coir fibers with 36.41% water which is the optimum moisture content of fly ash under Standard proctor conditions to give proper consistency to the mixture for easy moulding.
- The wet mixture is then compacted in a constant volume mould with static compactive force.
- After giving required compactive force the samples were ejected out from the mould.
- The size of specimens were 75mm dia. & 150mm in height.
- In this series of tests the percentage of Coir fibers used were 0.2%, 0.5 %, 1 %, and 2 %.
- The length of coir fiber used were 1 cm and 2 cm.

<u>Sample preparation IV (Fly Ash + Coir Fibers) at Modified proctor conditions.</u>

- The specimens for UCS test are prepared by mixing required weight of fly ash and Coir fibers with 32.25% water which is the optimum moisture content of fly ash under Modified proctor conditions to give proper consistency to the mixture for easy moulding.
- The wet mixture is then compacted in a constant volume mould with static compactive force.
- After giving required compactive force the samples were ejected out from the mould.
- The size of specimens were 75mm dia. & 150mm in height.
- In this series of tests the percentage of Coir fibers used were 0.2%, 0.5 %, 1 %, and 2 %.
- The length of coir fiber used were 1 cm and 2 cm.

CHAPTER 5

TEST RESULTS & DISCUSSION

STRESS-STRAIN RELATIONSHIP

<u>FLYASH + RECRON FIBERS</u>

Typical sets of stress – strain curves were obtained from unconfined compressive strength tests conducted on compacted fly ash – Recron with fiber contents of 0.2%, 0.5%, 1% and 2%. These stress-strain curves show three distinct portions. Initially the stress increases linearly with axial strain, thereafter, a mild one-linear increases of stress occurs up to a peak value and finally the deviator stress tend to decrease with further increases in axial strain.

With the increase in fiber content the stress increases with strain up to a certain extent until failure occurs and the curve takes a downward turn. Thus with increase in fiber content ,the load carrying capacity of the sample soil also increases which is evident from the curves plotted.

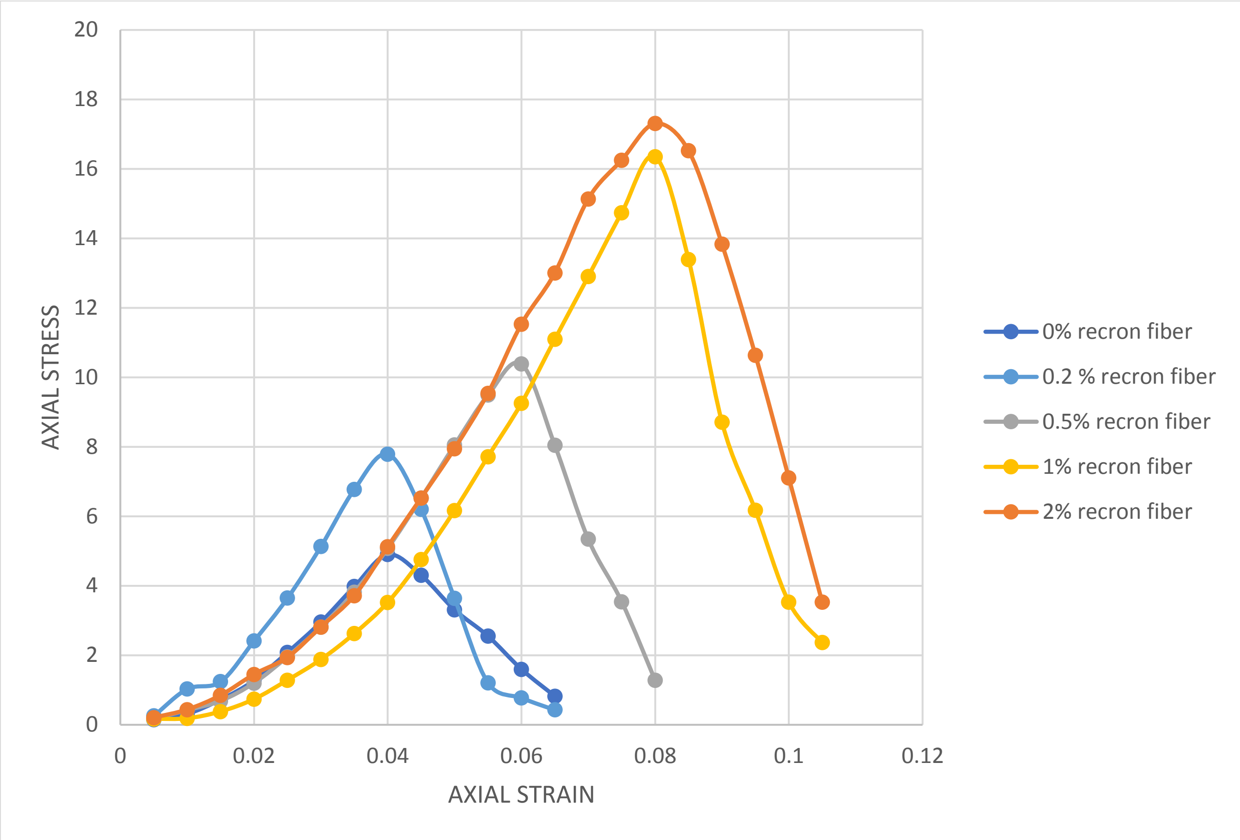

Figure 3 . Stress –Strain relationship curve of reinforced fly ash with recron fiber under modified proctor conditions

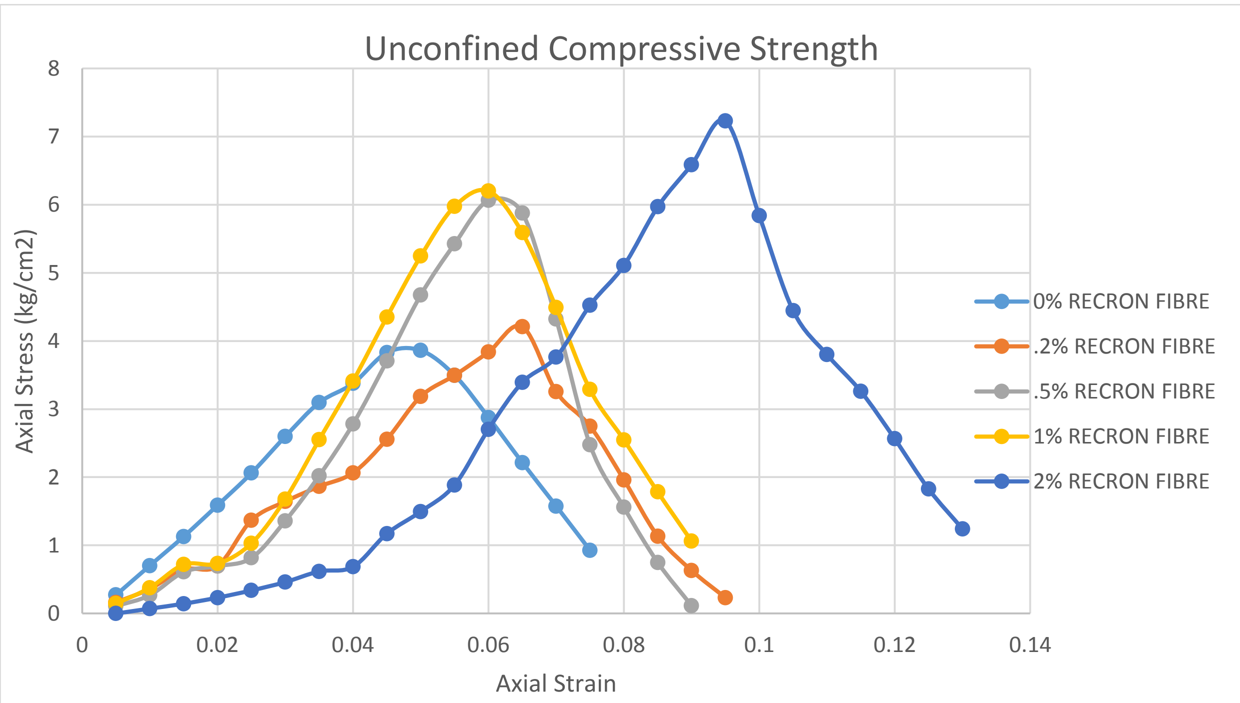

Figure 4 Stress –Strain relationship curve of reinforced fly ash with recron fiber under standard proctor conditions.

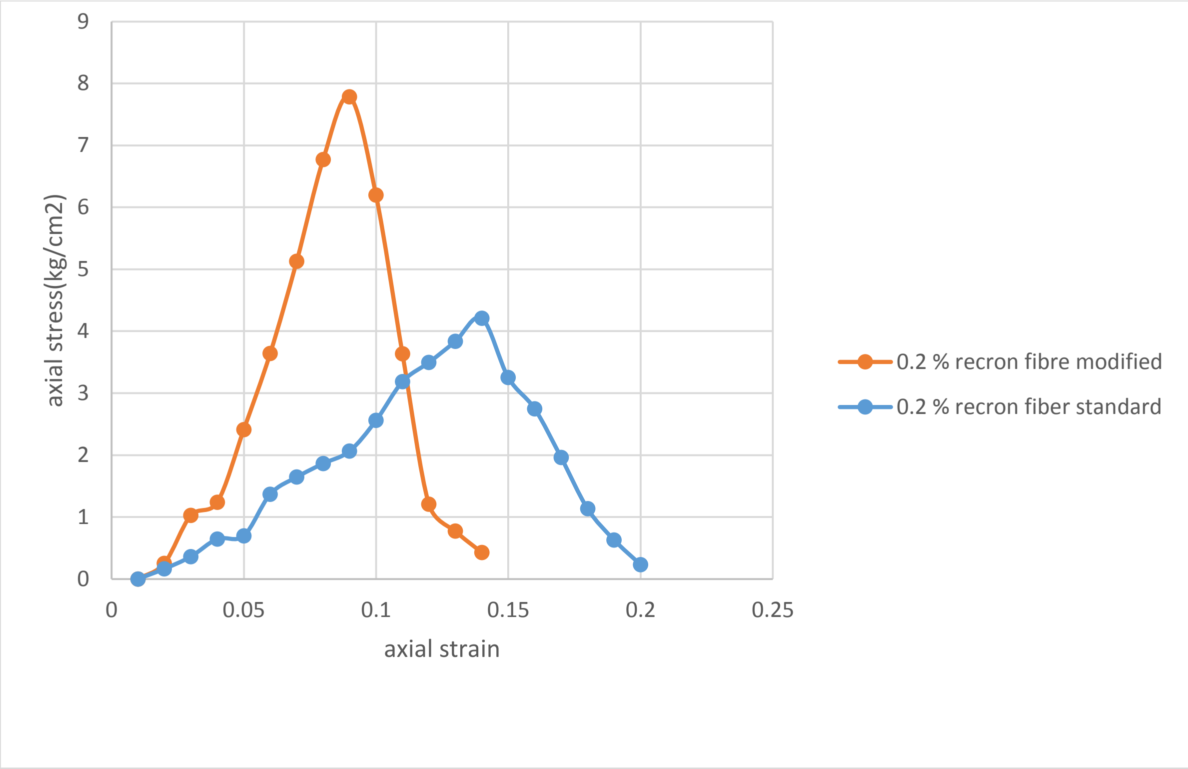

Figure 5 Stress –Strain relationship curve of reinforced fly ash with 0.2 % recron fiber under standard and modified proctor conditions.

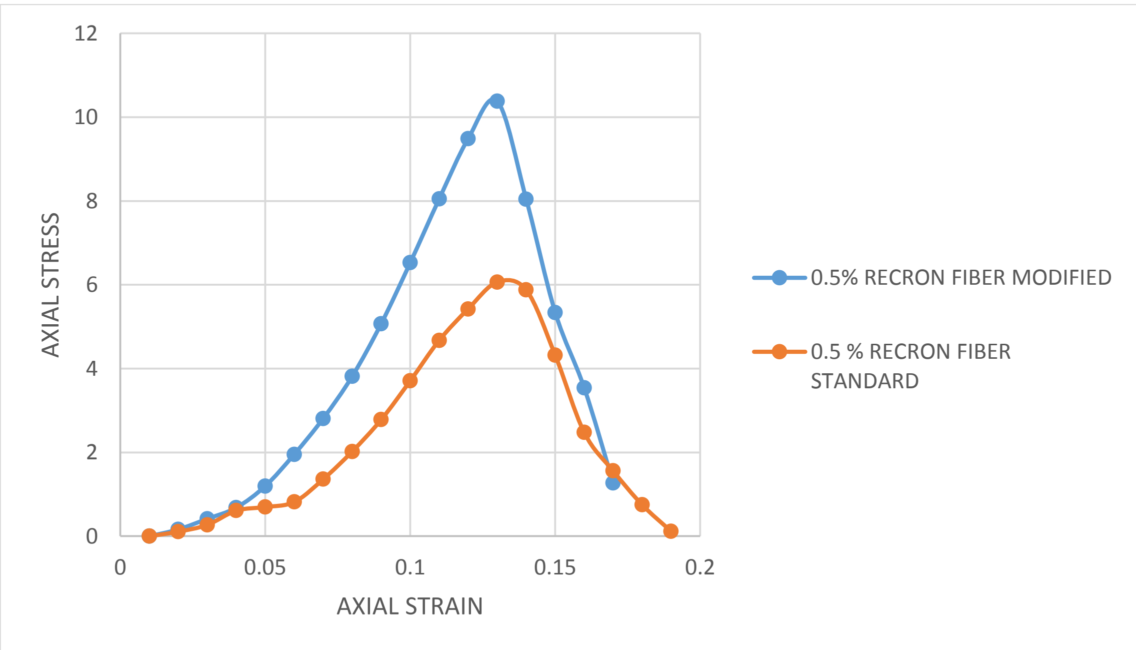

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Figure 6 Stress –Strain relationship curve of reinforced fly ash with 0.5% recron fiber under standard and modified proctor conditions.

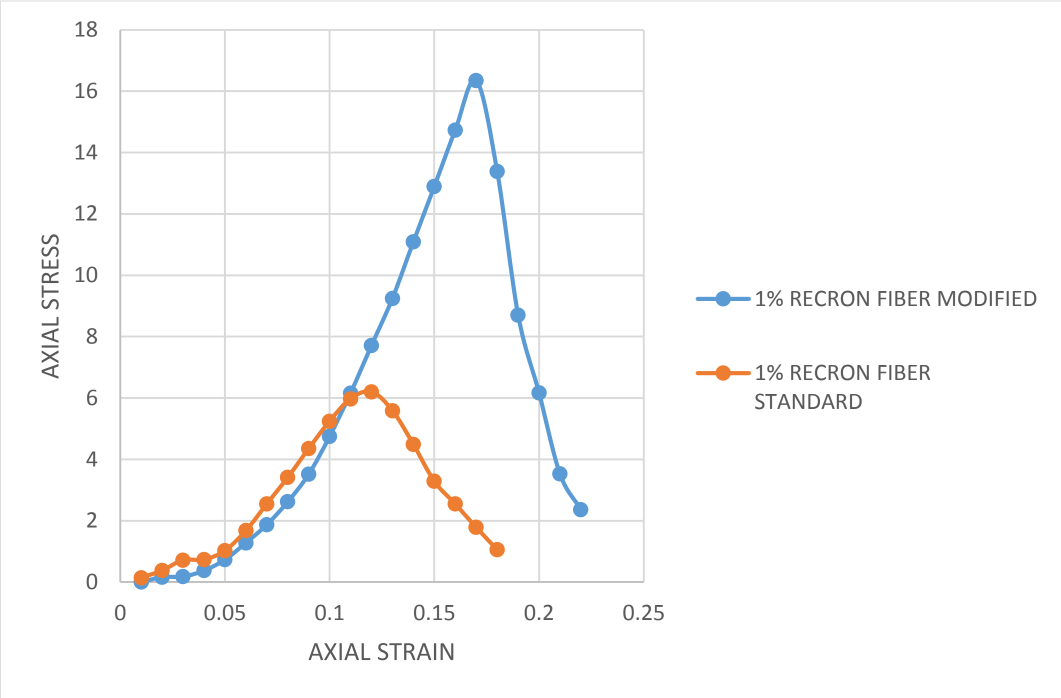

Figure 7 Stress –Strain relationship curve of reinforced fly ash with 1 % recron fiber under standard and modified proctor conditions.

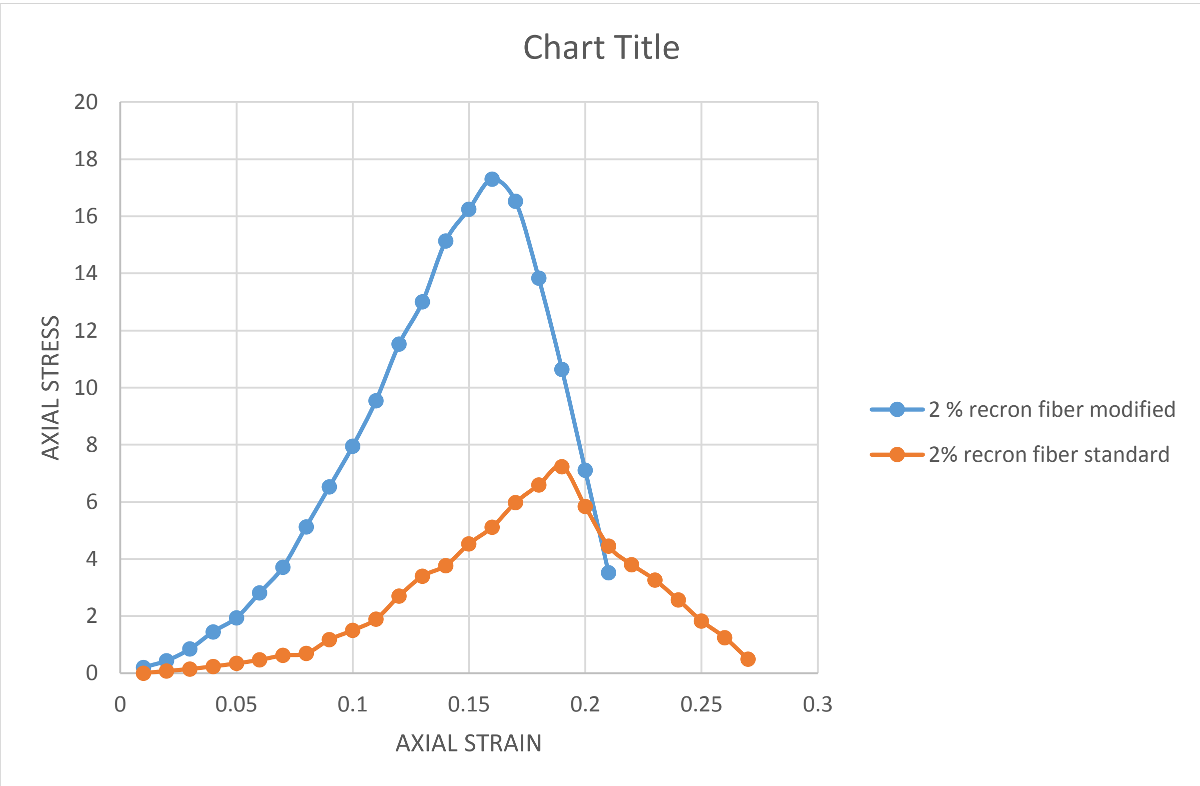

Figure 8 Stress –Strain relationship curve of reinforced fly ash with 2 % recron fiber under standard and modified proctor conditions.

Figure 3-6 shows the comparison between the stress –strain curve of reinforced fly ash under standard proctor conditions and modified proctor conditions with same fiber content.

FLYASH + COIR FIBERS

Typical sets of stress – strain curves were obtained from unconfined compressive strength tests conducted on compacted fly ash – Recron with fiber contents of 0.2%, 0.5%, 1% and 2%. These stress-strain curves show three distinct portions.

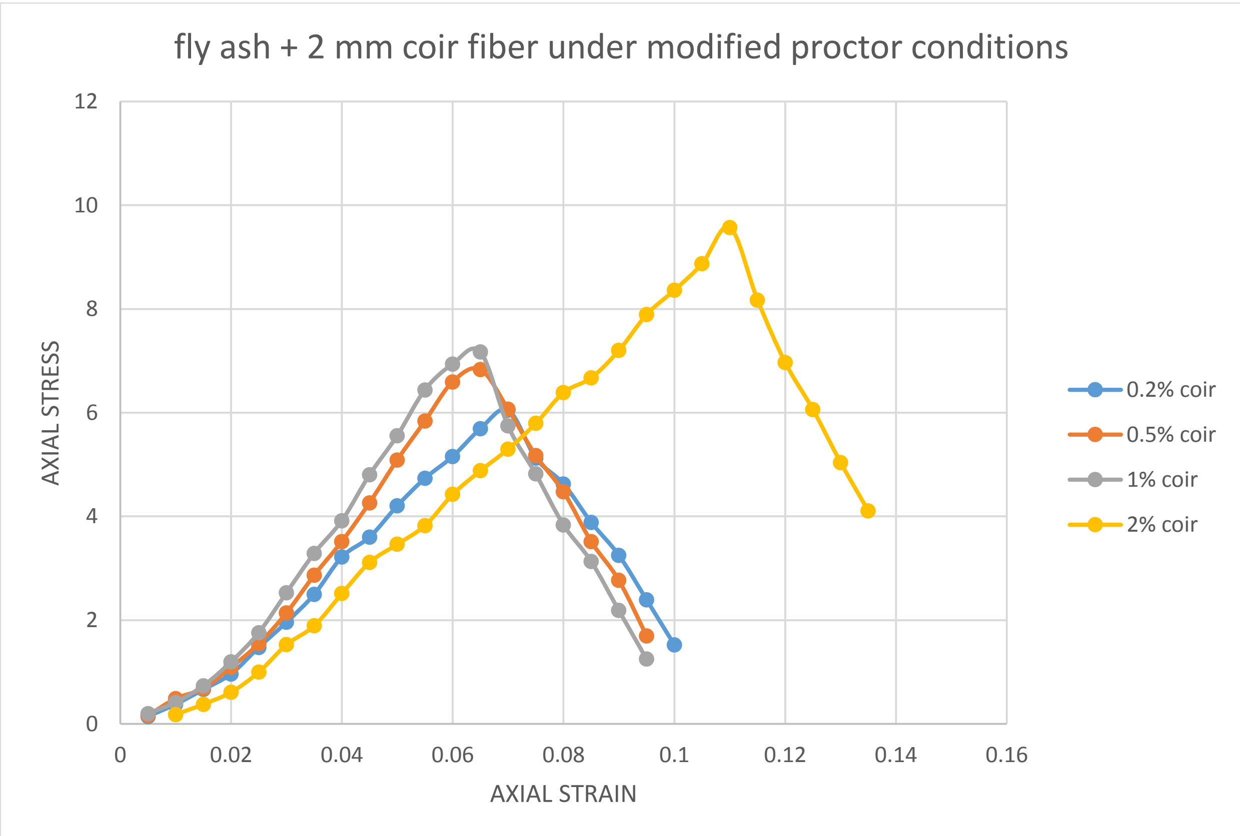

Figure 9 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 2 mm length under modified proctor conditions.

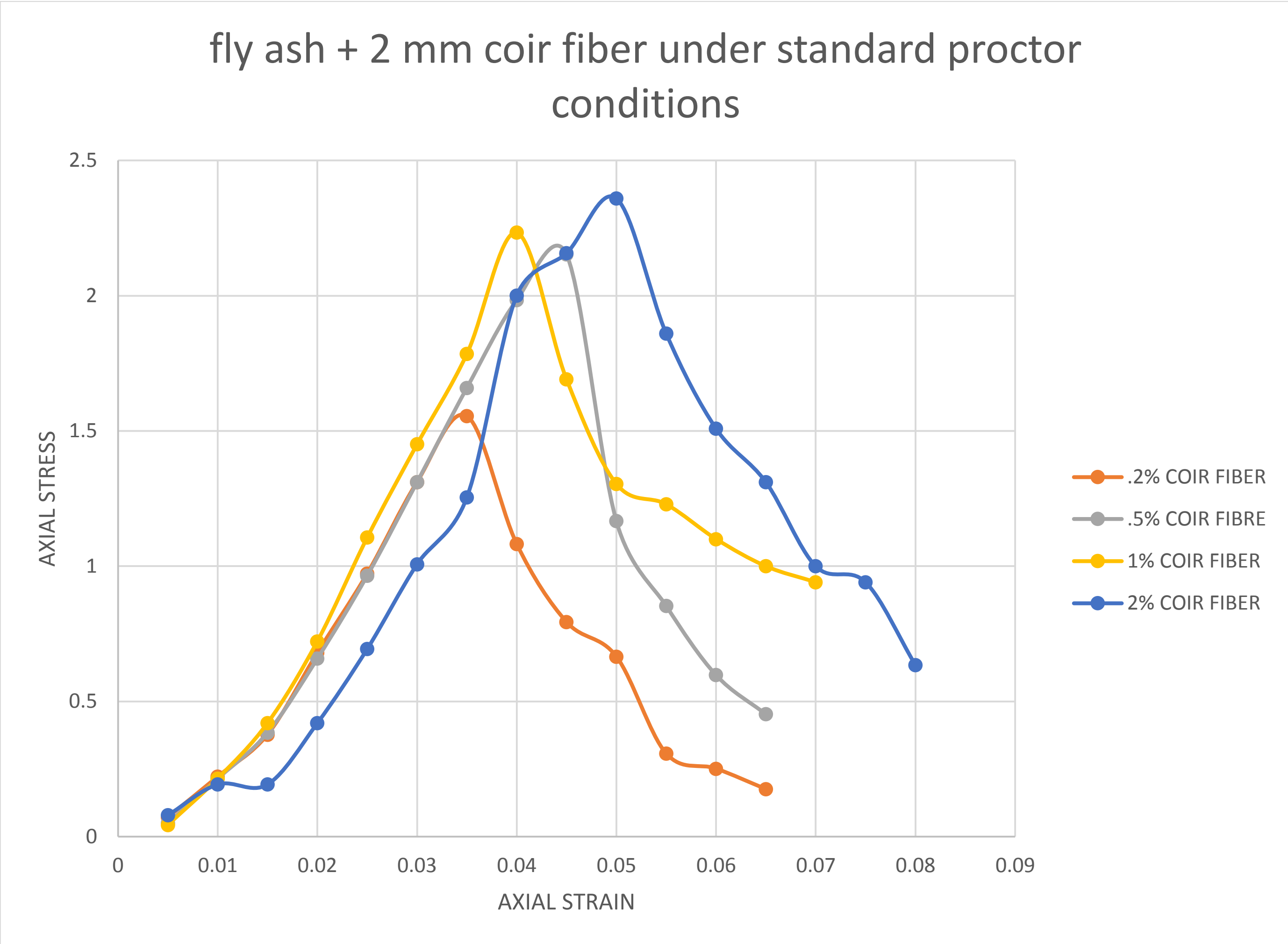

Figure 10 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 2 mm length under standard proctor conditions.

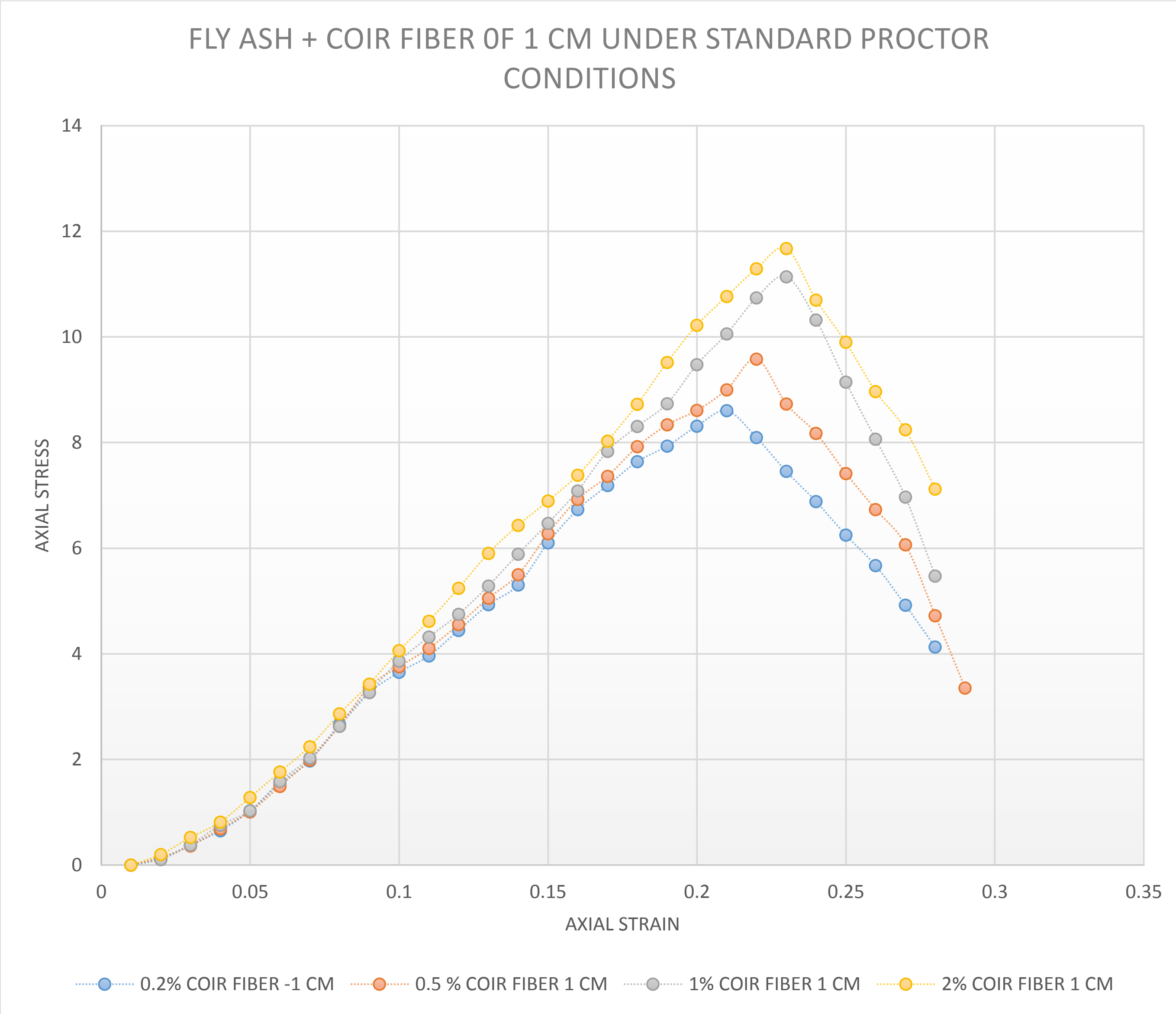

Figure 11 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 1 cm length under standard proctor conditions.

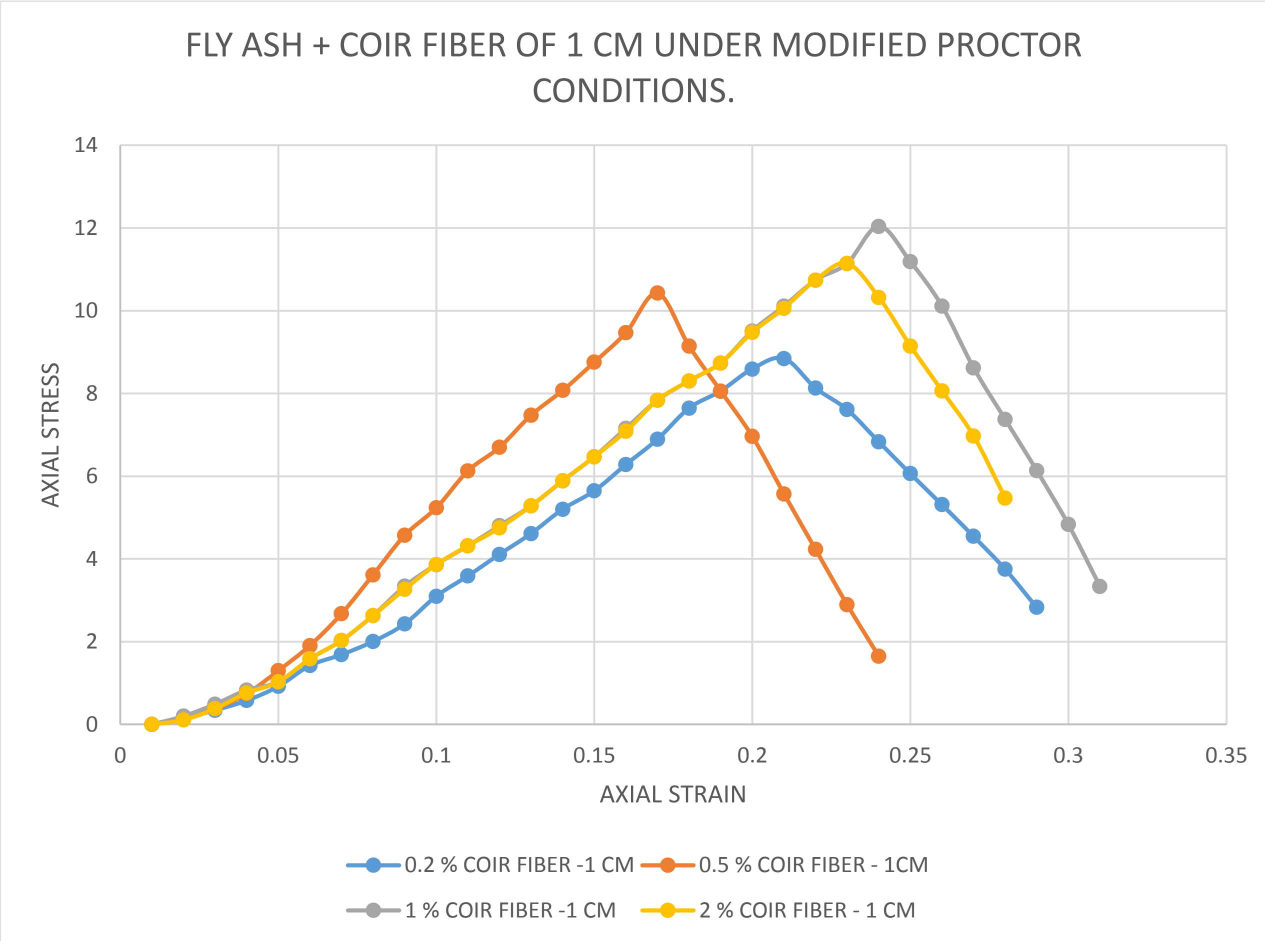

Figure 12 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 1 cm length under modified proctor conditions.

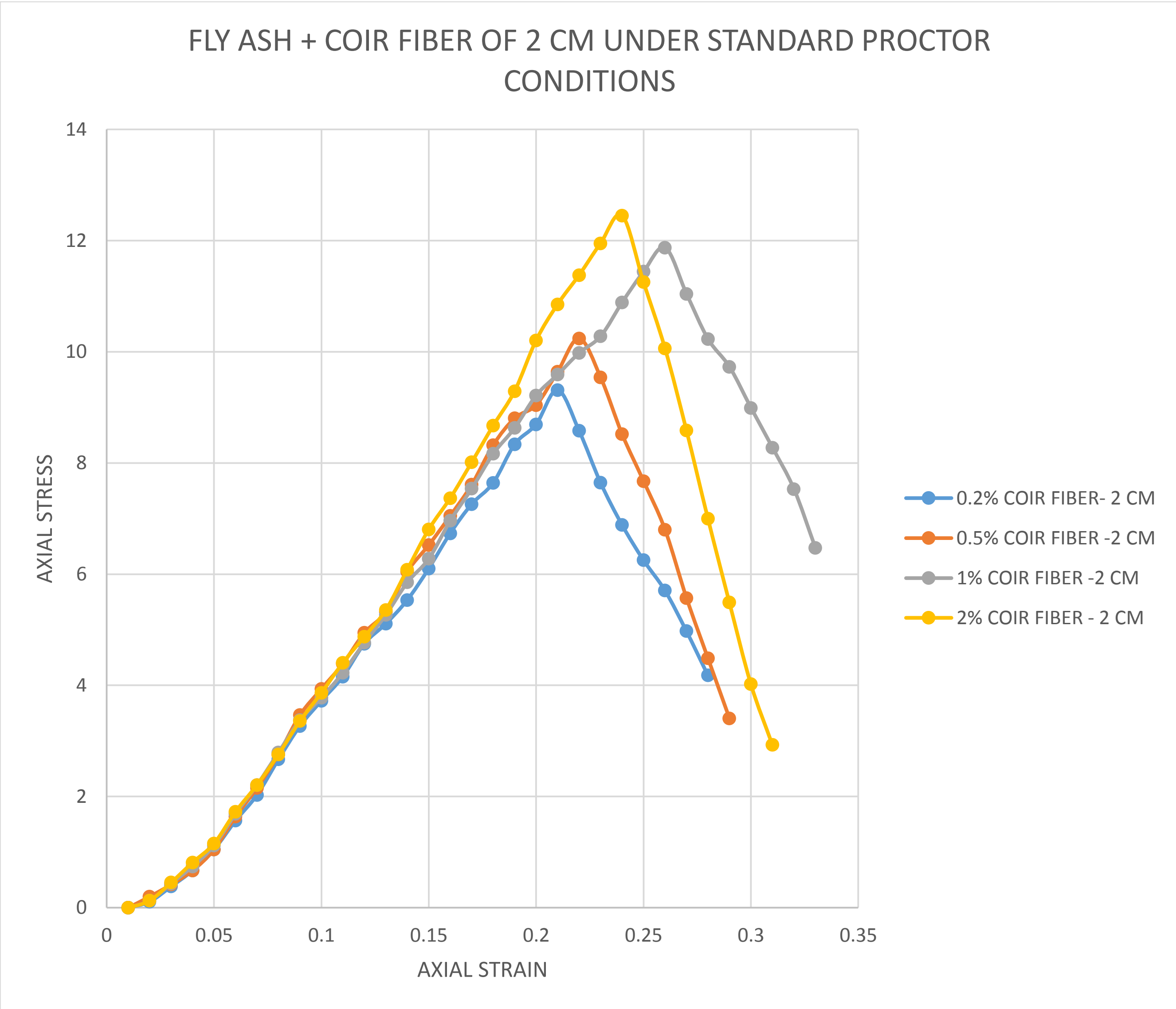

Figure 13 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 2 cm length under standard proctor conditions.

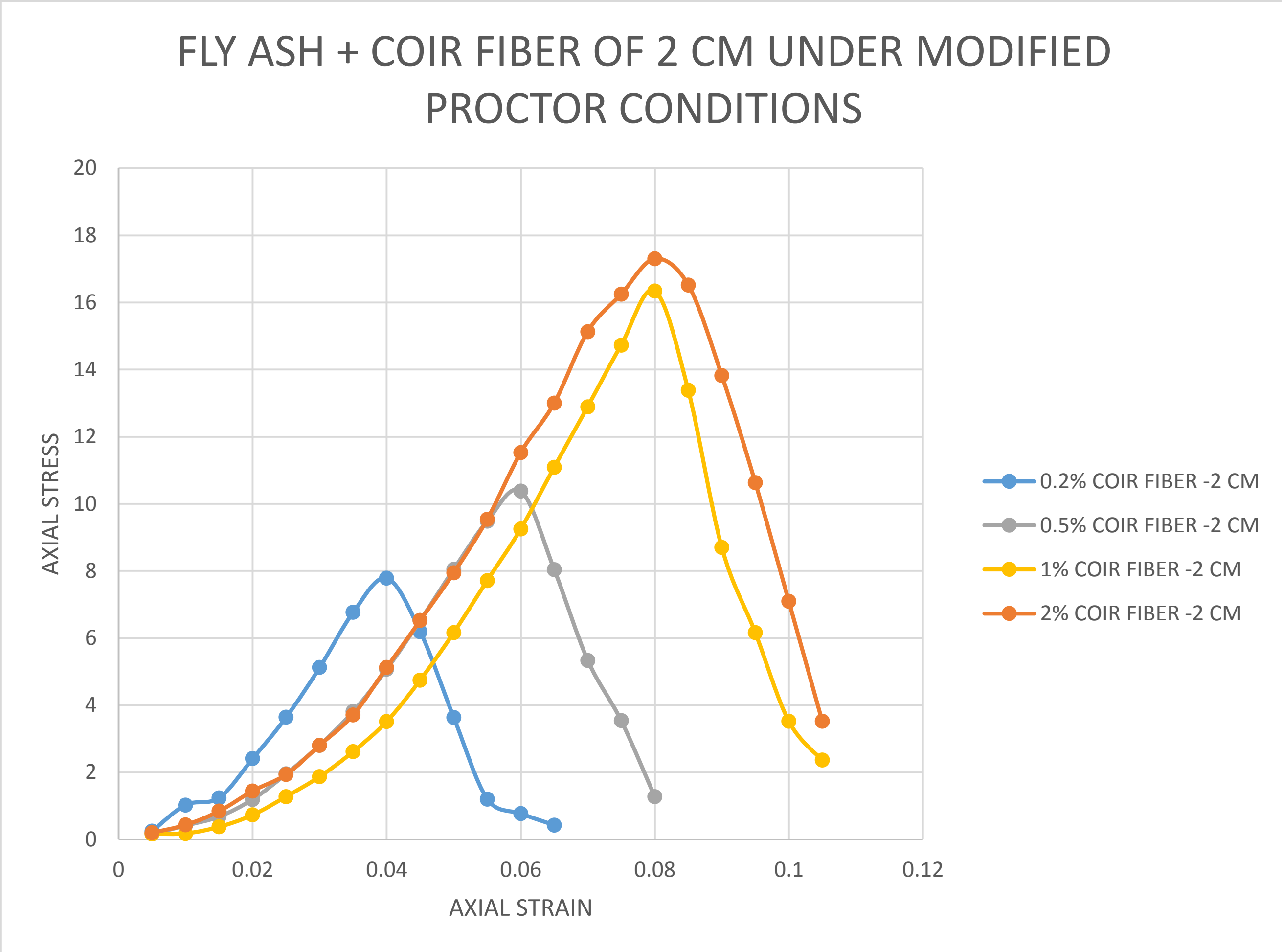

Figure 14 Stress –Strain relationship curve of reinforced fly ash with coir fiber of 2 cm length under modified proctor conditions.

CHAPTER 6

CONCLUSION

The effect of fiber reinforcements in modifying the stress – strain properties of compacted fly ash has been studied in a series of unconfined compression tests. Two separate kinds of fibers were taken into account, one natural fiber, coir fiber and another artificially made fiber namely recron fiber. The fiber content in the compacted fly ash was used as 0.2%, 0.5 %, 1% and 2. Based on the findings of the present investigation the following main conclusion are arrived.

- Fly ash is a more or less well-graded material having low specific gravity compared to conventional earth material.
- Fly ash possesses no plasticity, indicating that the inter-particular forces are either absent or negligible.
- Addition of fiber increases the strength or load carrying capacity of the mix.

- These stress-strain curves show three distinct portions. Initially the stress increases linearly with axial strain, thereafter, a mild one-linear increases of stress occurs up to a peak value and finally the deviator stress tend to decrease with further increases in axial strain.
- Increase in percentage of fibers by weight into the soil increases the strength of the fly ash.
- In case of using coir fiber as reinforcement material, when the length of the fiber is increased, there is an increase in strength as well.
- Samples prepared under modified proctor conditions tests to show more strength than the samples prepared under standard proctor conditions at same fiber content.

Both Coir and Recron fibers are effective in increasing the strength of the compacted fly ash. This also modifies the stress-strain behavior of the mass. The utilization of fly ash in conjunction with fiber reinforcement in geotechnical constructions will solve problems in one effort viz. elimination of solid waste and provision of a much needed construction material.

CHAPTER 7

REFERENCES

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